and at the end of the assay. Tests conducted on varieties known to be susceptible or tolerant to nematodes proved the reliability of the method. We will search for nematode-tolerant hybrids among the ones selected for their general agronomic performance and fruit qualities using this newly developed method.

Ongoing research also is aims at understanding the mechanisms leading to post-harvest internal browning (IB) induced by cold during fruit storage. The induction of polyphenoloxydase activities in response to cold storage is measured within leaves and fruits and correlations are searched for. A specific objective is to identify molecular probes for susceptibility to IB that could be used as an early selection tool within hybrid progenies.

CIRAD Pineapple Genebank Database Online

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As a result of years of collection and germplasm exchange, and of an EU-funded project in which institutions from Brazil, France and Venezuela collaborated, CIRAD has gathered hundreds of pineapple cultivars and species of the genus *Ananas* and a wide collection of over 600 accessions has been established in Martinique, FWI, at the CIRAD research centre. This collection includes a wide range of genotypes from many geographic origins, and is presently the most diverse in existence. All accessions in the genebank have been evaluated using common methods for the characterization and evaluation of pineapple germplasm. As a tool to promote information exchange and germplasm utilisation, CIRAD developed a database built on a standardised format. However, the database and its valuable information were not easily accessible to anyone. The development of a joint CIRAD-INRA (Institut National de la Recherche Agronomique) project to build a Tropical Plants Biological Resources Centre (CRB) of the French West Indies made it possible to develop a web portal and give open access to the database directly on the internet. This website makes it possible to get information on cultivated plants conserved by CIRAD and INRA in Guadeloupe and Martinique: sugarcane, bananas, yam, perennial fruit crops, flowers and pineapple. Eventually, the portal will be trilingual: French, English and Spanish. The Tropical Plants Biological Resources Centre of the French West Indies portal is currently accessible though not all features have been implemented. Access to the portal is at http://collections.antilles.inra.fr/BRCPortal/initHome.do.

Ethephon on Pineapple: News About Uses and Regulation

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Introduction

The use of ethephon in pineapple was proposed in the 1970s by CIRAD agronomists in Martinique and Côte d'Ivoire to reduce the time between the harvest of early ripe fruits and the harvest of the late ripe fruits in a pineapple field and to get a more homogeneous external colour of the fruits (Audinay, 1970; Poignant, 1971). Ethephon does not actually colour the fruit, it rather degreens the shell of the fruit by destruction of chlorophyll. The closer the fruit is to natural ripening, the more efficient is the degreening. If correctly applied at the right time, ethephon treatment does not reduce significantly the internal quality of the fruit. This technique drastically changed the management of the harvest because formerly the desired tonnage was harvested from many fields whereas with ethephon degreening the same tonnage could be obtained from only few fields. Few drawbacks to ethephon degreening have been identified as long as the application follows the recommendations (2 – 3 L ha^{-1} when ~1% of fruits begin to colour naturally). One drawback is that sometimes fruits are relatively insensitive to the treatment, for example when high levels of nitrogen have been applied during vegetative growth. This has generally a consequence, the farmer applies higher doses of ethephon, earlier (as many as 3 to 4 weeks before natural ripening sometimes). The result is fruit with poor quality, with a shorter shelf life, withered crowns after cold storage and fruit more sensitive to Internal Browning. With the development of new varieties and also the general evolution of customer sensitivity to the use of pesticides in agriculture, one could expect some changes in the use of ethephon.

Ethephon, degreening in new varieties and other uses

Degreening of the fruits: The hybrids MD2, which is produced on a large scale in many countries and Flhoran 41, the red hybrid from CIRAD, showing the same behavior after ethephon application. These hybrids both have a shorter interval from Forcing to Harvest than does 'Smooth Cayenne' (about one week), they naturally degreen faster and the gradient of colour between the bottom and top of the fruit is very small. We realized that a lower dose of ethephon can be applied to the fruit of these two varieties (1.0 L ha^{-1} on 60 000 fruits) to get the correct colour : yellow for the MD2 and red for the Flhoran 41. The red colour is clearly enhanced by ethephon treatment through its promotion of anthocyanin biosynthesis. One of the beneficial effects of the treatment on MD2 is that it reduces the risk of over ripening of the fruit as this variety is very susceptible to this problem. On a practical basis, we also noticed that growers use the same dose they are used to with 'Smooth Cayenne'.

Reduction of peduncle length: One of the characteristics of MD2 is its short peduncle. The fruits are "deep" inside the plant and better protected from sun burn and lodging. We did experiments on Flhoran 41 to reduce the peduncle length with ethephon application in the heart of the plant 3 to 4 weeks after forcing. We found that the peduncle is shortened (5 to 10 cm depending on the dose and time of application) without any negative effects on fruit quality. The best dose/time application seems to be 3 to 4.0 L ha^{-1} of ethephon applied 3 weeks after forcing in our condition in Martinique. Adjustments are probably needed in different production areas and for other varieties.

Forcing: Ethephon is commonly used for forcing in many production areas where the day-night temperature difference is high enough to naturally increase the sensitivity of pineapple to forcing. Recent experiments in Guadeloupe showed that late applications of ethephon in the afternoon not only increased the percentage of forced plants (91% for a late afternoon application vs 30% for application around mid-day) but also increased the number of fruitlets/fruit, leading to a 20% increase in yield. Higher doses also induced a significant reduction of peduncle length (20%).

Ethephon as a residue in fruit and new regulations on pesticides uses

European regulations on the use of pesticides are becoming more and more detailed and strict. A lot of phytosanitary products used on pineapple have been banned for pineapple production on European territories, and Maximal Residue Levels (LMR) established for production imported into Europe. For ethephon on pineapple the LMR is 2 mg kg^{-1}, which is also the limit adopted by the Codex Alimentarius. One can expect in the near future that the LMR will be fixed at detection level which means a level far below the current one and probably, at last, ethephon will be banned. Previous experimentations during the 80s in Côte d'Ivoire (Soler,1992) showed that most of the ethephon applied remains as a dry residue at the surface of the skin. Only 20% to 40%, depending on the external temperature, actually penetrates inside the fruit, but the experiments showed also that the dry residue on the skin may be re-dissolved by dew or light rains leading to further penetration of ethephon inside the fruits. Ethephon is then transformed into ethylene and after 12 days (fruits left on the plant in the field) only 5% could be detected inside the fruit. More recent experiments have been conducted especially regarding the residue levels vs the local practices (ethephon applications of 3, 6 and 9 L ha^{-1} on 55 000 fruits) during years 2001-2002 (Teisson, 2001; Bourgeois, 2002). The results confirm that a low dose of ethephon does not signicantly reduce fruit quality and also shows that residue levels are below the authorized limit. Meanwhile higher doses reduce Brix levels (1 to 2 %), increase acidity level (1 meq $100ml^{-1}$) and lead to residue levels as high as four times the authorized limit. In la Réunion island where the 'Queen' cultivar is grown, ethephon is also used for degreening. As the production is in a European territory, they pay particular attention to residue problems. Producers not only need to reduce the dose to a minimum level, they also have established a minimum time before harvest of 2 weeks for the treatment (Joas, 2006).

Conclusion

Ethephon is still a very useful "tool" for pineapple farmers, but as far as fruit degreening is concerned, this chemical is expected to be banned soon. New varieties such as MD2 and Flhoran 41 that do not need the chemical to get their colour represent definitively a strong commercial advantage for the producers. At this stage it is difficult to imagine what will be the regulation about the use of ethephon for forcing or to reduce peduncle length. The applications in these treatments are made long before harvest and no residue problem should be expected from them. Nevertheless it is not impossible that a ban of the chemical for degreening would also mean a ban for any uses on pineapple.

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Growth Characteristics of the Pineapple Cultivars 'MD2' and 'Flhoran 41' Compared With 'Smooth Cayenne'

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Introduction

New pineapple varieties are now well established in the markets and this "segmentation" will increase in the near future to offer consumers a real choice of differentiated products such as already exists for other fruits. At the growers level, different pineapple cultivars also means a need to adapt the cultural practices due to different behaviours of the cultivars in terms of growth, nutrient requirements and sensitivity to biotic and abiotic stresses. Examples of this diversified behaviour include:

- Ethephon dose for degreening may be lower for 'MD2', 'Flhoran 41' and 'Queen' than for 'Smooth Cayenne'
- 'MD2' is sensitive to phytophthora and to over-ripening but insensitive to Internal Browning
- 'Flhoran 41' is sensitive to soil-borne parasitism but shows exceptional quality characteristics for fresh market as well as for processing and does not need ethephon for degreening.
- 'Queen' shows very good fruit quality with a high level ascorbic acid but is very sensitive to Wilt and Internal Browning.

In addition, each variety has some unique growth characteristics.

Growth characteristics : plant weight, D leaves and number of leaves

We measured a few growth characteristics of 'MD2', 'Flhoran 41' and 'Smooth Cayenne', between planting and forcing. Classical planting material was used, in this case 400 g suckers, which are less susceptible to natural flower induction than bigger suckers (PY, 1960; Lacoeuilhe, 1975). The suckers were planted at a density of 55 000 plants/ha in Côte d'Ivoire during May 2005, a hot and humid period. The maximum temperatures ranged between 26.7 to 33.5°C with rainfall of 1700mm during the 10 months of the experimentation. Because the period of the experiment was very wet the plants were not irrigated.

Plant weights were similar for the three cultivars and the speed of growth also was similar. Exportable fruits, average weight 1.5kg, are obtained with 2.5 kg plants. This weight was reached, on average, after 240 days for 'Flhoran 41', 242 days for 'MD2' and 252 days for 'Smooth Cayenne'.

The increase in weight of the D leaves (as defined by Py *et al*, 1984) of the three cultivars shows the same pattern and follows the classical sigmoid growth curve observed for pineapple (Lacoeuilhe, 1976; Py, 1973) (Figure 1). 'MD2' D leaves had a greater weight than those of the other cultivars, about 10 g up to four-five months after planting. Then gradually the weight of 'Smooth Cayenne' D leaves increased until they were similar in weight to those of 'MD2' plants. The weight of 'Flhoran 41' D leaves follows the same pattern as did those for 'Smooth Cayenne' plants from planting to the 5th month but at the end averaged 10 g less than those of the two other cultivars.

'Flhoran 41' consistently had a higher number of leaves than did 'Smooth Cayenne', which had a higher number of leaves than did 'MD2'. Leaf numbers at 16 weeks after planting were 41 for 'Flhoran 41', 36 for 'Smooth Cayenne' and 30 for 'MD2' (Figure 2). At the time of forcing leaf numbers were 62 for 'Flhoran 41', 55 for 'Smooth Cayenne' and 50 for 'MD' (Figure 2).

Clearly 'Flhoran 41' has more but smaller leaves than either 'Smooth Cayenne' or 'MD2'. Since the weights of all plants were similar, under good growth conditions 'Florhan 41' compensates for having smaller leaves by having more of them. Finally, we confirmed that the classical correlation between D leaf weight and plant weight holds for these new cultivars.

We also observed the same behaviour on the same cultivars in greenhouse experiments in Martinique, (plants in pots, experiments still underway). The impact of nematodes on the three cultivars was evaluated by multiplying *Rotylenchulus reniformis* on *Phaseolus vulgaris* and then inoculating half the pots with this nematode during a 2-month growth period. Meanwhile the other half of the pots were freed from nematodes by a 2-month immersion of the soil before planting. The reduction of foliar emission due to nematodes was 10% on 'Flhoran 41' vs 2% for 'Smooth Cayenne' and 6% for 'MD2'. The D leaf weight was reduced by 62% and 59%, respectively, for the nematode sensitive 'Flhoran 41' and 'Smooth Cayenne' cultivars but was reduced only by 29% on 'MD2', which is more tolerant to *Rotylenchulus reniformis*.